Auxiliary Science from the WFIRST-AFTA Microlensing Survey.

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WFIRST-AFTA SDT Telecon
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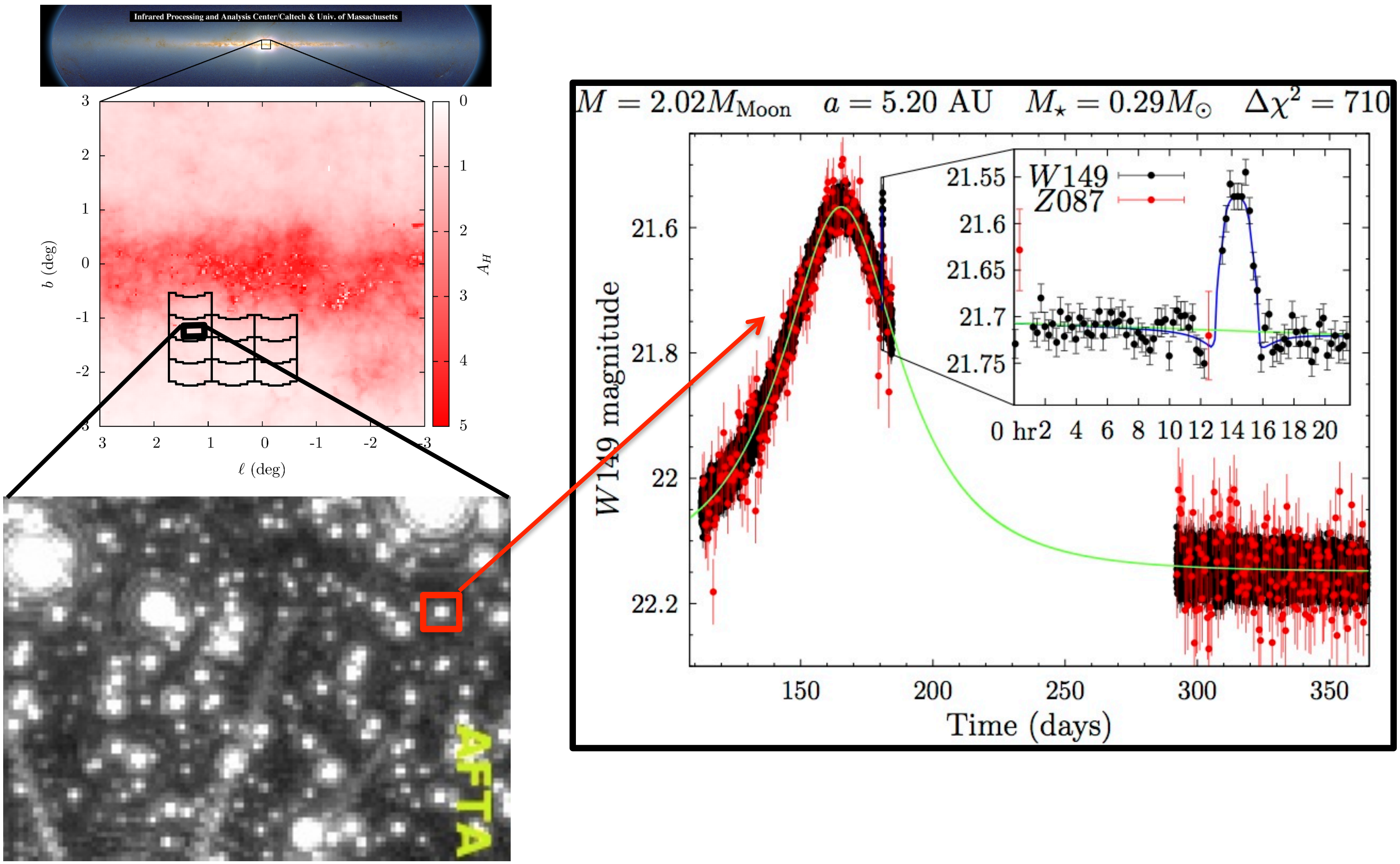
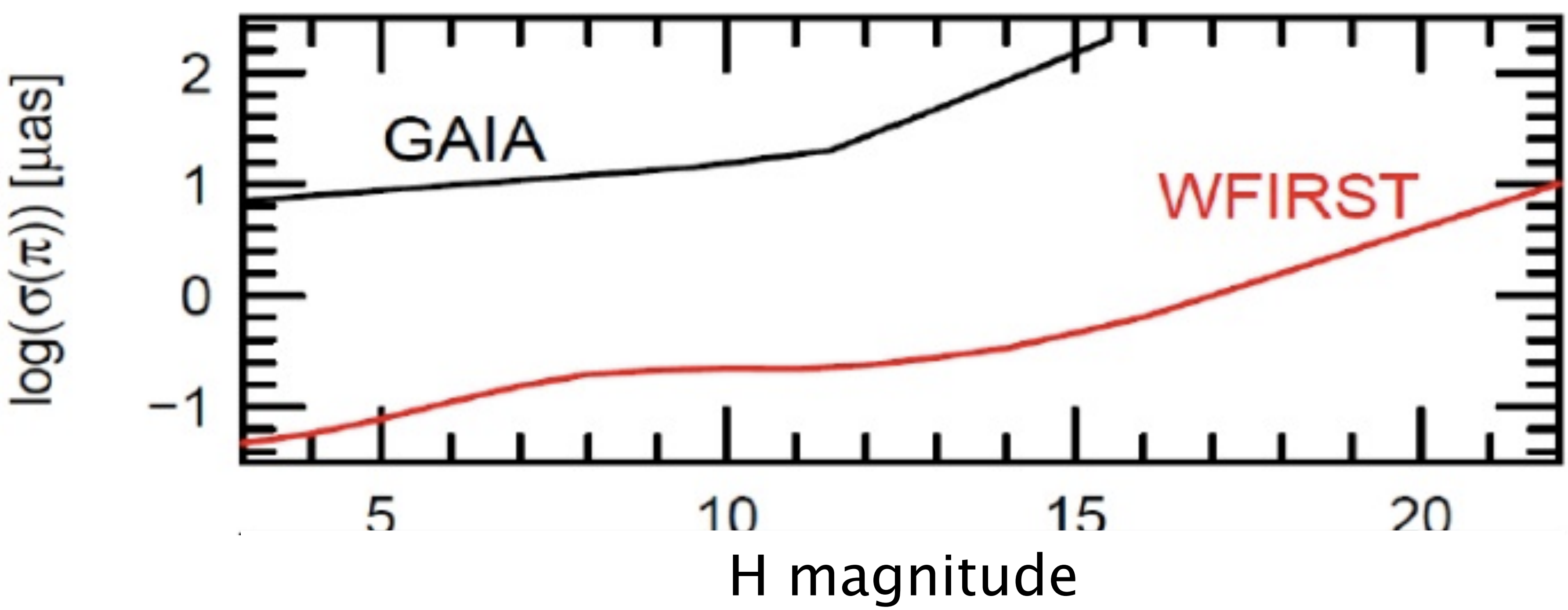
(with input from A. Gould, D. Bennett, M. Penny)

Microlensing Survey.



WFIRST-AFTA Parallaxes.



- H<14.0; σ(π) < 0.3 μas; 1,000,000 stars
- H<19.6; σ(π) < 3.7 μas; 40,000,000 stars
- H<21.6; σ(π) < 10 μas; 120,000,000 stars

Gould et al. (2014)

Microlensing Survey Dataset.

Properties.

- ~3 sq. deg.
- ~1 year total time.
- ~80% of the area will have ~2 million seconds of integration time.
- ~100 million stars down to H<22, with ~40,000 measurements per star (~10% in bluer filter), $N^{-1/2} = 1/200$
- ~1 billion photons for a H=19.5 star.
- Incredible statistical power -> systematics, systematics, systematics.

Auxiliary Science Overview.

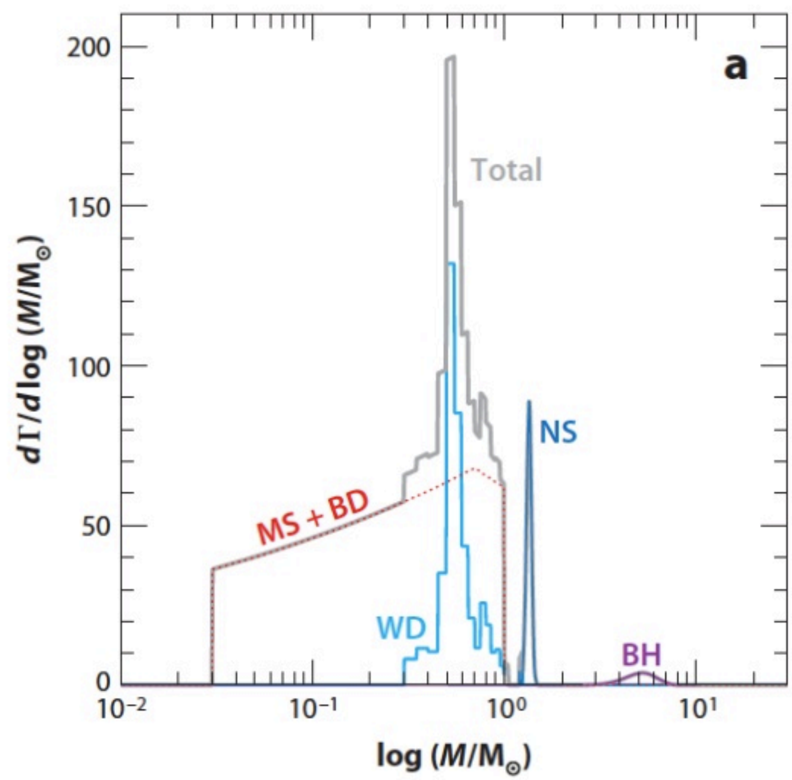
Topics:

- Microlensing Auxiliary Science.
- Planets.
- Stars.
- Galactic Structure.
- Solar System.

Caveat: Admixture of things that have and have not been thought about carefully.

Microlensing Auxiliary Science.

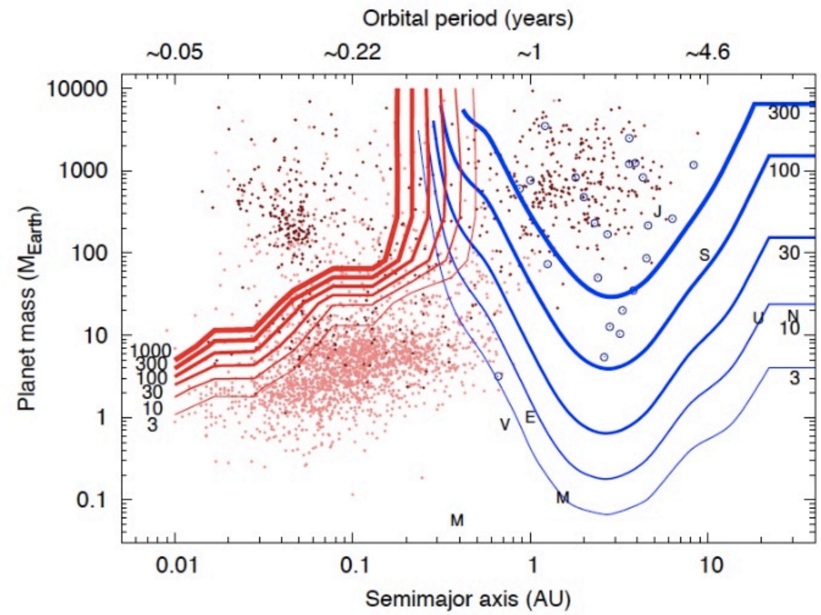
- Compact object mass function over ~8 orders of magnitude (Mars to ~30 M_{sun})
  - Binary mass and separation distributions.
  - Triple systems.
  - Remnant mass function.
- Optical depth.
- Limb darkening.



Gould (2000)

Planets.

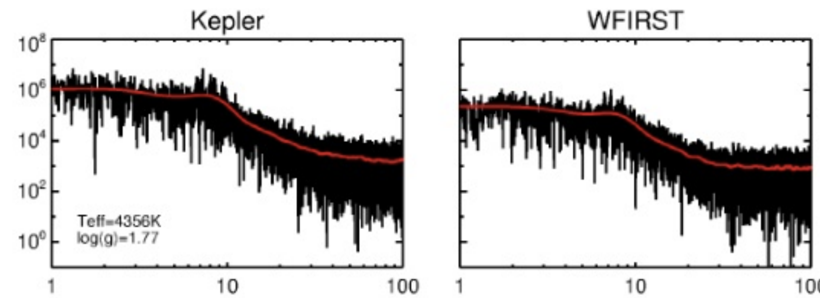
- Transiting planets.
  - $O(10^5)$ detections.
  - Sensitivity down to Neptunes.
  - Long periods via single transits.
- Astrometric planets.
  - $\sigma_\pi \sim 0.3\mu as$ for H<14 (Gould et al. 2014)
  - $M > 3M_J\,(a/AU)^{-1}\,(d/kpc)$ at 10σ

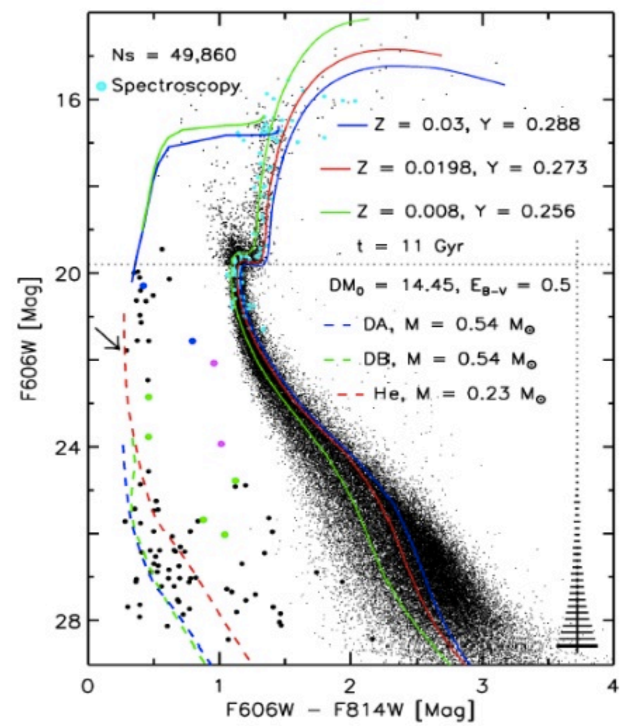


McDonald et al. (2014) see also Bennett & Rhie (2002), Gould et al. (2014)

Stars.

- Asteroseismology of giants.
- Young stars & blue stragglers.
- Variables.
  - Flares, CVs, Novae, RR Lyrae, Miras, …
- Clusters.
- X-ray sources.
- Dark companions.
- White dwarfs.

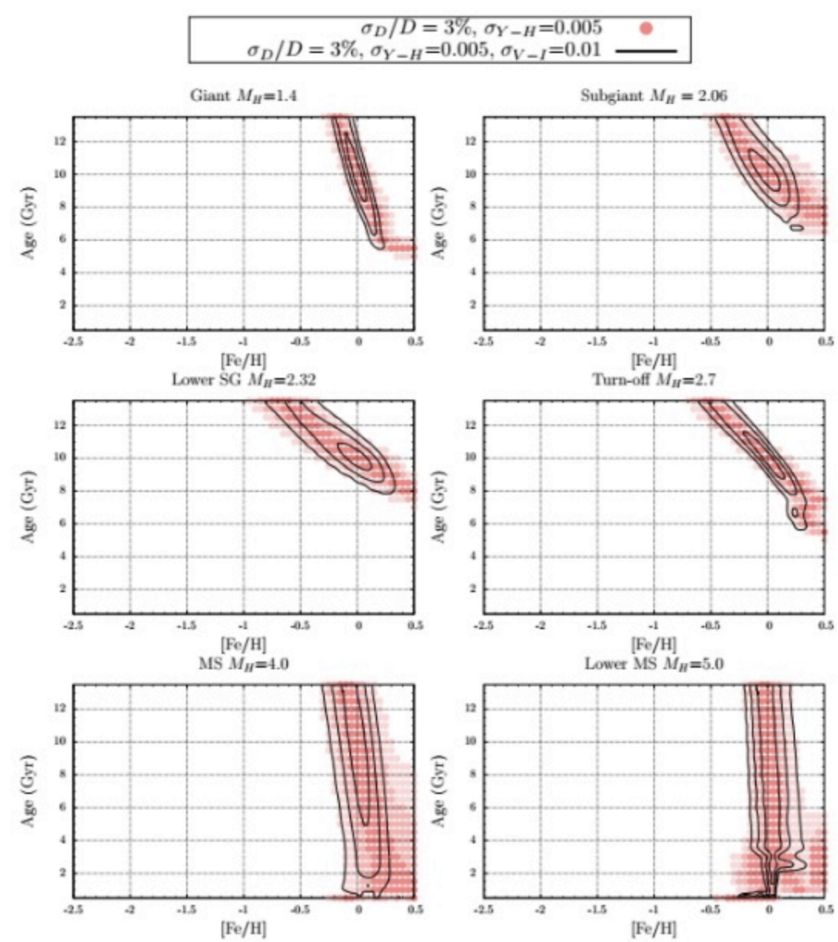




Gould et al. (2014), Calamida et al. (2014), Clarkson et al. (2011)

Galactic Structure.

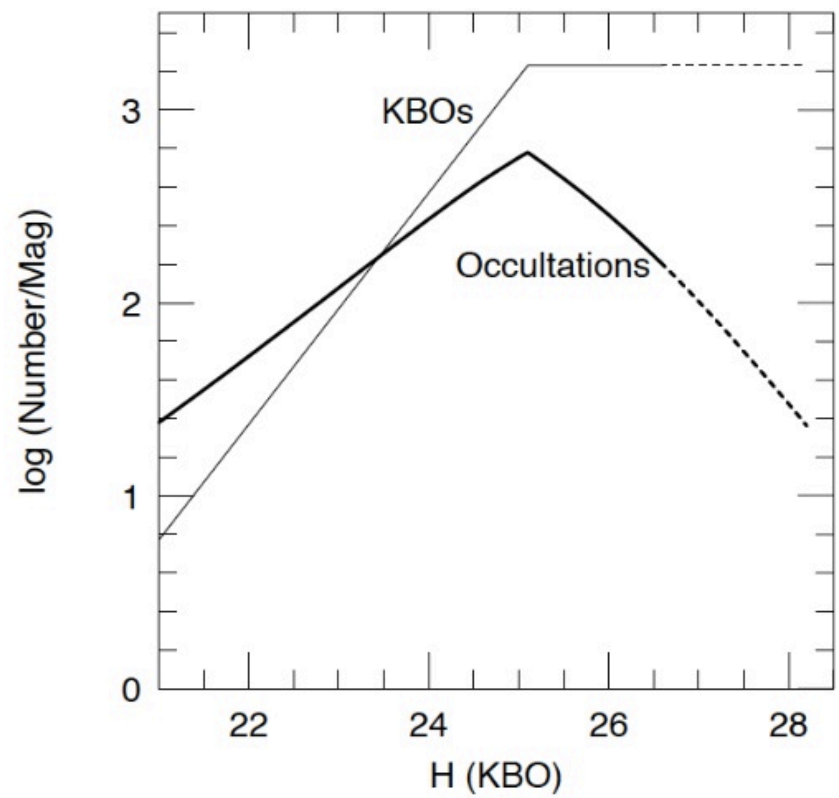
- Parallaxes (<10%) and PM (<0.3%) for 10^8 bulge and disk stars.
- T_{eff}, Metallicities, Luminosities & A_V from multicolor photometry.
- Science:
  - Bulge mass and velocity distribution and bar structure.
  - Disk and bulge dust distribution.
  - Disk structure, velocity distribution.
  - Metallicity and age distribution of bulge and disk.



Simulation by Matthew Penny.

Solar System.

- Detect ~5000 KBOs down to H~28 (D~10 km) over ~17 deg^2
- Fractional errors in orbital elements of a few %
- Binary companions down to H~29.
- ~1000 occultations.



Gould 2014

Related Projects.

- HST Galactic Bulge Treasury Program (PI T. Brown)
- Sagittarius Window Eclipsing Extrasolar Planet Search (PI K. Sahu)
- Vista Variables in the Via Lactea (VVV, Minniti et al. 2010)
- Blanco DECam Bulge Survey (BDBS, PI M. Rich)
- Japan Astrometry Satellite Mission for Infrared Exploration (JASMINE, PI N. Gouda)
  - Nano-JASMINE (5cm mirror) launch 2015

Precursor Observations.

- With HST imaging of (a subset of?) bulge fields in bluer filters:
  - Metallicities, ages, distances, and foreground extinction for stars with WFIRST parallaxes and proper motions.
  - Test proper motion and astrometric microlensing measurements.
  - Locations and colors of stars in the microlensing fields with higher resolution and fidelity than WFIRST or Euclid.
  - Test pipeline.
- And/Or…
  - Subaru imaging?
  - …

WFIRST-AFTA Design and Survey Considerations.

- Calibration strategy.
- Slew/settle time & dither strategy.
- Bluer filter(s) ?
- Absolute parallaxes?
  - Gaia.
  - Background QSOs.
- Associated GO programs.
  - Wider, shallower surveys.
  - Deeper exposures of target fields in bluer filters.

Summary/To Do.

- Potentially very rich dataset, for both microlensing and non-microlensing science, as well as for calibration of the detector.
- In order to take advantage of this dataset, we need to:
  - Think about what else might be done.
  - Work out (in detail) what can actually be done.
  - Understand how and how well it can be used to calibrate the detector.
  - Figure out what additional measurements we might need to make now to maximally leverage this dataset for these purposes.